

Contract: Greater Dublin Drainage Scheme

Job No.: 14-645

**UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS**

D = core diameter  
 L = specimen length  
 M = specimen mass  
 P = applied load for failure

$\rho_b$  = Bulk Density ( $4M \times 10^6 / \pi \times D^2 \times L$ )  
 MCS = Uncorrected compressive strength ( $4P \times 10^3 / \pi \times D^2$ )  
 UCS = Size corrected uniaxial compression strength (MCS x F)  
 F = Size correction factor for core  $L/D < 2$  ( $0.89 + 0.11 \times (L/D - 1)$ )

Sheet 1 of 1

Borehole	Specimen Depth (m bgl)	Specimen Diameter D (mm)	Specimen Length L (mm)	Specimen Mass M (kg)	Failure Load P (tonf)	Failure Load P (kN)	Bulk Density $\rho_b$ (Mg/m <sup>3</sup> )	Measured Compressive Strength (MCS) (MPa)	Correction Factor F	Uniaxial Compressive Strength (UCS) (MPa)	Remarks
BH106	4.45-5.50										Testing not possible. Sample broke while attempting trimming. No suitable replacement
BH107	5.50	83	206	3.017	40.0	398.6	2.71	73.66	1.00	73.7	-
BH107	4.30	83	193	2.817	7.0	69.7	2.70	12.89	1.00	12.9	-
BH108	3.60	70	171	1.826	7.5	74.7	2.77	19.42	1.00	19.4	-
BH109	3.70	70	197	2.142	14.5	144.5	2.83	37.54	1.00	37.5	-
BH110	4.00	70	173	1.885	24.5	244.1	2.83	63.43	1.00	63.4	-
BH111	2.50	83	205	3.014	2.5	24.9	2.72	4.60	1.00	4.6	-

Contract: Greater Dublin Drainage Scheme

Job No.: 14-645

W = core diameter (Axial test) or specimen width (Irregular lump test)

D = core diameter (Diametral test) or specimen length (Axial test/Irregular lump test)

L = measured applied load for failure

P = actual applied load for failure (L x calibration factor)

D' = distance between platens at point of failure

$D_e^2 = D \times D'$  (Diametral test)

$D_e^2 = 4/p (W \times D')$  (Axial test / Irregular lump test)

$I_s = \text{Uncorrected point load strength } (P/D_e^2)$

$I_{s(50)} = \text{Size corrected point load strength } (I_s \times F)$

$F = (D_e/50)^{0.45}$  Size correction factor for core other than 50mm diameter

Sheet 1 of 1

**POINT LOAD STRENGTH TEST RESULTS**

Borehole	Specimen Depth (m bgl)	Test Type A = Axial D = Diametral I = Irregular	W (mm)	D (mm)	D' (mm)	L (kN)	P (kN)	De <sup>2</sup> (mm <sup>2</sup> )	De (mm)	Is (MPa)	F	Is(50) (MPa)	Remarks
BH106	4.50	D		83	78	12.0	12.0	6474	80.46	1.85	1.24	2.29	Invalid
BH106	5.60	D		83	80	8.3	8.3	6640	81.49	1.25	1.25	1.56	Valid
BH107	3.50	A	83	50	42	13.2	13.2	4439	66.62	2.97	1.14	3.38	Invalid
BH107	5.20	D		83	79	4.1	4.1	6557	80.98	0.62	1.24	0.78	Invalid
BH108	3.30	D		70	66	5.8	5.8	4620	67.97	1.25	1.15	1.44	Invalid
BH108	5.10	D		71	68	4.6	4.6	4828	69.48	0.95	1.16	1.10	Invalid
BH109	4.80	D		70	67	3.2	3.2	4690	68.48	0.68	1.15	0.79	Valid
BH110	5.00	D		70	67	17.4	17.4	4690	68.48	3.71	1.15	4.27	Valid
BH111	3.50	D		83	80	3.2	3.2	6640	81.49	0.48	1.25	0.60	Valid
BH111	4.50	D		83	79	6.9	6.9	6557	80.98	1.05	1.24	1.31	Valid

## LABORATORY RESTRICTION REPORT

Project Reference	14-645	To	Darren O'Mahony
Project Name	Greater Dublin Drainage Scheme Ground Investigation	Position	Project Manager
TR reference	14-645 / 1	From	Stephen Watson
		Position	Laboratory Manager

The following sample(s) and test(s) are restricted as detailed below. Could you please complete the "Required Action" column and return the completed form to the laboratory.

Hole Number	Sample			Test Type	Reason for Restriction	Required Action
	Number	Depth (m)	Type			
BH113		4.5	D	Natural mositure Atterberg PSD	No sample received	Testing cancelled
BH124		1.5	D	Natural mositure Atterberg PSD	No sample received	Testing Cancelled

For electronic reporting a form of electronic signature or printed name is acceptable

Laboratory Signature Stephen Watson	Project Manager Signature Darren O'Mahony
Date 25 February 2015	Date 25 February 2015



**TEST RESTRICTION FORM**

Issue No. 1  
Page 1 of 1  
Date 25/02/2015



# Final Report

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**Report Number:** 15-01364 Issue-1

**Initial Date of Issue:** 29-Jan-15

**Client:** Causeway Geotech Ltd

**Client Address:** 8 Drumahiskey Road  
Balnamore  
Ballymoney  
County Antrim  
BT53 7QL

**Contact(s):** Darren O'Mahony  
Paul Dunlop  
Stephen Franey

**Project:** 14-645 Greater Dublin Drainage GI - Phase 2

**Quotation No.:** **Date Received:** 23-Jan-15

**Order No.:** 47-645 **Date Instructed:** 23-Jan-15

**No. of Samples:** 8 **Results Due:** 29-Jan-15

**Turnaround:  
(Weekdays)** 5

**Date Approved:** 29-Jan-15

**Approved By:**

**Details:** Darrell Hall, Laboratory Director

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## Results Summary - Soil

### Project: 14-645 Greater Dublin Drainage GI - Phase 2

Client: Causeway Geotech Ltd	Chemtest Job No.:		15-01364	15-01364	15-01364	15-01364	15-01364	15-01364	15-01364		
Quotation No.:	Chemtest Sample ID.:		92555	92556	92557	92558	92559	92560	92561		
Order No.: 47-645	Client Sample Ref.:										
	Client Sample ID.:		BH120	BH121	BH121	TP100	TP101	BH122	BH138		
	Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL		
	Top Depth (m):		0.50	0.50	1.00	0.30	0.20	7.50	0.90		
	Bottom Depth(m):										
	Date Sampled:		22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15		
Determinand	Accred.	SOP	Units	LOD							
Moisture	N	2030	%	0.02	21	10	9.5	17	19	12	6.4
pH	U	2010								8.6	8.5
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.01						0.029	0.030
Arsenic	U	2450	mg/kg	1	25	26	30	38	34		
Barium	U	2450	mg/kg	10	200	140	160	130	60		
Cadmium	U	2450	mg/kg	0.1	2.1	2.7	2.5	0.55	0.35		
Chromium	U	2450	mg/kg	1	21	21	15	21	21		
Copper	U	2450	mg/kg	0.5	61	31	27	27	27		
Mercury	U	2450	mg/kg	0.1	0.39	< 0.10	< 0.10	< 0.10	< 0.10		
Molybdenum	U	2450	mg/kg	2	5.7	7.5	8.9	2.4	< 2.0		
Nickel	U	2450	mg/kg	0.5	44	64	51	72	60		
Lead	U	2450	mg/kg	0.5	94	24	21	48	43		
Antimony	N	2450	mg/kg	2	2.6	2.1	< 2.0	< 2.0	< 2.0		
Selenium	U	2450	mg/kg	0.2	0.35	< 0.20	< 0.20	< 0.20	< 0.20		
Zinc	U	2450	mg/kg	0.5	100	84	73	74	75		
LOI	U	2610	%	0.1	15	1.7	1.6	2.7	2.7		
Total Organic Carbon	U	2625	%	0.2	7.0	0.46	0.58	0.63	0.55		
TPH >C6-C10	N	2670	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
TPH >C10-C21	N	2670	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
TPH >C21-C40	N	2670	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
Total TPH >C6-C40	U	2670	mg/kg	10	< 10	< 10	< 10	< 10	< 10		
Naphthalene	U	2800	mg/kg	0.1	0.38	0.32	0.55	0.97	1.2		
Acenaphthylene	N	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Acenaphthene	U	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluorene	U	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	0.12	0.26		
Phenanthrene	U	2800	mg/kg	0.1	0.42	0.12	0.21	0.30	0.55		
Anthracene	U	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Fluoranthene	U	2800	mg/kg	0.1	0.22	0.50	< 0.10	< 0.10	< 0.10		
Pyrene	U	2800	mg/kg	0.1	0.21	0.45	< 0.10	< 0.10	< 0.10		
Benzo[a]anthracene	U	2800	mg/kg	0.1	< 0.10	0.22	< 0.10	< 0.10	< 0.10		
Chrysene	U	2800	mg/kg	0.1	< 0.10	0.22	< 0.10	< 0.10	< 0.10		
Benzo[b]fluoranthene	N	2800	mg/kg	0.1	< 0.10	0.18	< 0.10	< 0.10	< 0.10		
Benzo[k]fluoranthene	U	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Benzo[a]pyrene	U	2800	mg/kg	0.1	< 0.10	0.12	< 0.10	< 0.10	< 0.10		
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10		

## Results Summary - Soil

### **Project: 14-645 Greater Dublin Drainage GI - Phase 2**

Client: Causeway Geotech Ltd	<b>Chemtest Job No.:</b>		15-01364	15-01364	15-01364	15-01364	15-01364	15-01364	15-01364
Quotation No.:	<b>Chemtest Sample ID.:</b>		92555	92556	92557	92558	92559	92560	92561
Order No.: 47-645	Client Sample Ref.:								
	<b>Client Sample ID.:</b>		BH120	BH121	BH121	TP100	TP101	BH122	BH138
	Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):		0.50	0.50	1.00	0.30	0.20	7.50	0.90
	Bottom Depth(m):								
	Date Sampled:		22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15	22-Jan-15
<b>Determinand</b>	<b>Accred.</b>	<b>SOP</b>	<b>Units</b>	<b>LOD</b>					
Benzo[g,h,i]perylene	U	2800	mg/kg	0.1	< 0.10	0.11	< 0.10	< 0.10	< 0.10
Coronene	N	2800	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 17 PAH's	N	2800	mg/kg	2	< 2.0	2.2	< 2.0	< 2.0	2.0
PCB 28	U	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
PCB 52	U	2815	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
PCB 101	U	2815	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
PCB 118	U	2815	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
PCB 153	U	2815	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
PCB 138	U	2815	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
PCB 180	U	2810	mg/kg	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Total PCBs (7 Congeners)	N	2815	mg/kg	0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

## Results Summary - Single Stage WAC

**Project: 14-645 Greater Dublin Drainage GI - Phase 2**

<b>Chemtest Job No: 15-01364</b> <b>Chemtest Sample ID: 92555</b> <b>Sample Ref:</b> <b>Sample ID: BH120</b> <b>Top Depth(m): 0.50</b> <b>Bottom Depth(m):</b> <b>Sampling Date: 22-Jan-2015</b>				<b>Landfill Waste Acceptance Criteria Limits</b>			
				Inert Waste Landfill	Stable, Non-reactive hazardous waste in non hazardous Landfill	Hazardous Waste Landfill	
Determinand	SOP	Accred.	Units				
Total Organic Carbon	2625	U	%		3	5	6
Loss on Ignition	2610	U	%		--	--	10
Total BTEX	2760	U	mg/kg		6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg		1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg		500	--	--
Total (of 17) PAHs	2700	N	mg/kg		100	--	--
pH	2010	U			--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg		--	To evaluate	To evaluate
Eluate Analysis			10:1 Eluate mg/l	10:1 Eluate mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg		
Arsenic	1450	U	0.003	< 0.050	0.5	2	25
Barium	1450	U	0.014	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.010	0.04	1	5
Chromium	1450	U	0.002	< 0.050	0.5	10	70
Copper	1450	U	0.005	0.054	2	50	100
Mercury	1450	U	< 0.0005	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.007	0.068	0.5	10	30
Nickel	1450	U	0.003	< 0.050	0.4	10	40
Lead	1450	U	0.002	0.023	0.5	10	50
Antimony	1450	U	0.001	0.012	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.010	0.1	0.5	7
Zinc	1450	U	0.006	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.19	1.9	10	150	500
Sulphate	1220	U	10	100	1000	20000	50000
Total Dissolved Solids	1020	N	110	1100	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	N	14	140	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.09
Moisture (%)	21

## Results Summary - Single Stage WAC

**Project: 14-645 Greater Dublin Drainage GI - Phase 2**

<b>Chemtest Job No: 15-01364</b> <b>Chemtest Sample ID: 92556</b> <b>Sample Ref:</b> <b>Sample ID: BH121</b> <b>Top Depth(m): 0.50</b> <b>Bottom Depth(m):</b> <b>Sampling Date: 22-Jan-2015</b>				<b>Landfill Waste Acceptance Criteria Limits</b>			
				<b>Inert Waste Landfill</b>	<b>Stable, Non-reactive hazardous waste in non hazardous Landfill</b>	<b>Hazardous Waste Landfill</b>	
Determinand	SOP	Accred.	Units				
Total Organic Carbon	2625	U	%		3	5	6
Loss on Ignition	2610	U	%		--	--	10
Total BTEX	2760	U	mg/kg		6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg		1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg		500	--	--
Total (of 17) PAHs	2700	N	mg/kg		100	--	--
pH	2010	U			--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg		--	To evaluate	To evaluate
Eluate Analysis			10:1 Eluate mg/l	10:1 Eluate mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg		
Arsenic	1450	U	< 0.001	< 0.050	0.5	2	25
Barium	1450	U	0.008	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.010	0.04	1	5
Chromium	1450	U	0.003	< 0.050	0.5	10	70
Copper	1450	U	0.001	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.013	0.13	0.5	10	30
Nickel	1450	U	< 0.001	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.010	0.1	0.5	7
Zinc	1450	U	0.002	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.2	2	10	150	500
Sulphate	1220	U	< 1.0	< 10	1000	20000	50000
Total Dissolved Solids	1020	N	56	560	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	N	25	250	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.09
Moisture (%)	10



## Results Summary - Single Stage WAC

**Project: 14-645 Greater Dublin Drainage GI - Phase 2**

<b>Chemtest Job No: 15-01364</b> <b>Chemtest Sample ID: 92557</b> <b>Sample Ref:</b> <b>Sample ID: BH121</b> <b>Top Depth(m): 1.00</b> <b>Bottom Depth(m):</b> <b>Sampling Date: 22-Jan-2015</b>					<b>Landfill Waste Acceptance Criteria Limits</b>		
					<b>Inert Waste Landfill</b>	<b>Stable, Non-reactive hazardous waste in non hazardous Landfill</b>	<b>Hazardous Waste Landfill</b>
Determinand	SOP	Accred.	Units				
Total Organic Carbon	2625	U	%		3	5	6
Loss on Ignition	2610	U	%		--	--	10
Total BTEX	2760	U	mg/kg		6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg		1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg		500	--	--
Total (of 17) PAHs	2700	N	mg/kg		100	--	--
pH	2010	U			--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg		--	To evaluate	To evaluate
Eluate Analysis			10:1 Eluate mg/l	10:1 Eluate mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg		
Arsenic	1450	U	< 0.001	< 0.050	0.5	2	25
Barium	1450	U	0.006	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.010	0.04	1	5
Chromium	1450	U	0.002	< 0.050	0.5	10	70
Copper	1450	U	0.002	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.005	0.053	0.5	10	30
Nickel	1450	U	< 0.001	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.001	< 0.50	4	50	200
Chloride	1220	U	1.1	11	800	15000	25000
Fluoride	1220	U	0.29	2.9	10	150	500
Sulphate	1220	U	4.6	46	1000	20000	50000
Total Dissolved Solids	1020	N	75	750	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	N	6.7	67	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.09
Moisture (%)	9.5

## Results Summary - Single Stage WAC

**Project: 14-645 Greater Dublin Drainage GI - Phase 2**

<b>Chemtest Job No: 15-01364</b> <b>Chemtest Sample ID: 92558</b> <b>Sample Ref:</b> <b>Sample ID: TP100</b> <b>Top Depth(m): 0.30</b> <b>Bottom Depth(m):</b> <b>Sampling Date: 22-Jan-2015</b>				<b>Landfill Waste Acceptance Criteria Limits</b>			
				<b>Inert Waste Landfill</b>	<b>Stable, Non-reactive hazardous waste in non hazardous Landfill</b>	<b>Hazardous Waste Landfill</b>	
Determinand	SOP	Accred.	Units				
Total Organic Carbon	2625	U	%		3	5	6
Loss on Ignition	2610	U	%		--	--	10
Total BTEX	2760	U	mg/kg		6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg		1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg		500	--	--
Total (of 17) PAHs	2700	N	mg/kg		100	--	--
pH	2010	U			--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg		--	To evaluate	To evaluate
Eluate Analysis			10:1 Eluate mg/l	10:1 Eluate mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg		
Arsenic	1450	U	< 0.001	< 0.050	0.5	2	25
Barium	1450	U	0.004	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.010	0.04	1	5
Chromium	1450	U	0.003	< 0.050	0.5	10	70
Copper	1450	U	< 0.001	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.004	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.001	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.25	2.5	10	150	500
Sulphate	1220	U	3.7	37	1000	20000	50000
Total Dissolved Solids	1020	N	57	570	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	N	3.8	< 50	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.09
Moisture (%)	17

## Results Summary - Single Stage WAC

**Project: 14-645 Greater Dublin Drainage GI - Phase 2**

<b>Chemtest Job No: 15-01364</b> <b>Chemtest Sample ID: 92559</b> <b>Sample Ref:</b> <b>Sample ID: TP101</b> <b>Top Depth(m): 0.20</b> <b>Bottom Depth(m):</b> <b>Sampling Date: 22-Jan-2015</b>					<b>Landfill Waste Acceptance Criteria Limits</b>		
					<b>Inert Waste Landfill</b>	<b>Stable, Non-reactive hazardous waste in non hazardous Landfill</b>	<b>Hazardous Waste Landfill</b>
Determinand	SOP	Accred.	Units				
Total Organic Carbon	2625	U	%		3	5	6
Loss on Ignition	2610	U	%		--	--	10
Total BTEX	2760	U	mg/kg		6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg		1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg		500	--	--
Total (of 17) PAHs	2700	N	mg/kg		100	--	--
pH	2010	U			--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg		--	To evaluate	To evaluate
Eluate Analysis			10:1 Eluate mg/l	10:1 Eluate mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg		
Arsenic	1450	U	< 0.001	< 0.050	0.5	2	25
Barium	1450	U	0.004	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.010	0.04	1	5
Chromium	1450	U	0.004	< 0.050	0.5	10	70
Copper	1450	U	0.002	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.003	< 0.050	0.5	10	30
Nickel	1450	U	0.001	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.010	0.1	0.5	7
Zinc	1450	U	0.002	< 0.50	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.24	2.4	10	150	500
Sulphate	1220	U	2.5	25	1000	20000	50000
Total Dissolved Solids	1020	N	59	590	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	N	3.9	< 50	500	800	1000

Soild Information	
Dry mass of test portion/kg	0.09
Moisture (%)	19

## Report Information

### **Key**

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- U UKAS accredited
- M MCERTS and UKAS accredited
- N Unaccredited
- S This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
- SN This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
- T This analysis has been subcontracted to an unaccredited laboratory
- I/S Insufficient Sample
- U/S Unsuitable sample
- N/E not evaluated
- < "less than"
- > "greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVCOs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at our Coventry laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

### **Sample Deviation Codes**

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- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container

### **Sample Retention and Disposal**

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All soil samples will be retained for a period of 60 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

[customerservices@chemtest.co.uk](mailto:customerservices@chemtest.co.uk)



# Final Report

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**Report Number:** 15-03477 Issue-1

**Initial Date of Issue:** 25-Feb-2015

**Client:** Causeway Geotech Ltd

**Client Address:** 8 Drumahiskey Road  
Balnamore  
Ballymoney  
County Antrim  
BT53 7QL

**Contact(s):** Darren O'Mahony  
Paul Dunlop  
Stephen Franey

**Project:** 14-645 Greater Dublin Drainage GI: Phase 2

<b>Quotation No.:</b>		<b>Date Received:</b>	16-Feb-2015
<b>Order No.:</b>	14-645	<b>Date Instructed:</b>	16-Feb-2015
<b>No. of Samples:</b>	7		
<b>Turnaround: (Wkdays)</b>	5	<b>Results Due Date:</b>	20-Feb-2015
<b>Date Approved:</b>	19-Feb-2015		

**Approved By:**

**Details:** Darrell Hall, Laboratory Director

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## Results Summary - Soil

**Project: 14-645 Greater Dublin Drainage GI: Phase 2**

Client: Causeway Geotech Ltd	<b>Chemtest Job No.:</b>		15-03477	15-03477	15-03477	15-03477	15-03477	15-03477	15-03477		
Quotation No.:	<b>Chemtest Sample ID.:</b>		103328	103329	103330	103331	103332	103333	103334		
Order No.: 14-645	Client Sample Ref.:										
	<b>Client Sample ID.:</b>		BH138	BH139	TP108	TP109	TP110	TP113	TP114		
	Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL		
	Top Depth (m):		0.00	6.00	2.00	1.00	0.50	1.00	2.00		
	Bottom Depth(m):										
	Date Sampled:										
<b>Determinand</b>	<b>Accred.</b>	<b>SOP</b>	<b>Units</b>	<b>LOD</b>							
pH	U	2010				8.3	8.2	8.1	8.2	8.4	
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.01		0.12	0.064	0.93	< 0.010	< 0.010	
Chloride (Extractable)	U	2220	g/l	0.01	< 0.010			< 0.010	< 0.010		
Organic Matter	U	2625	%	0.4	5.5			1.9	0.95	0.66	0.81

## Report Information

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- I/S Insufficient Sample
- U/S Unsuitable sample
- N/E not evaluated
- < "less than"
- > "greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVCOs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at our Coventry laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

### **Sample Deviation Codes**

---

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
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- D - Broken Container

### **Sample Retention and Disposal**

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All soil samples will be retained for a period of 60 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

[customerservices@chemtest.co.uk](mailto:customerservices@chemtest.co.uk)



# Final Report

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**Report Number:** 15-03479 Issue-1

**Initial Date of Issue:** 25-Feb-2015

**Client:** Causeway Geotech Ltd

**Client Address:** 8 Drumahiskey Road  
Balnamore  
Ballymoney  
County Antrim  
BT53 7QL

**Contact(s):** Darren O'Mahony  
Paul Dunlop  
Stephen Franey

**Project:** 14-645 Greater Dublin Drainage GI: Phase 2

**Quotation No.:** **Date Received:** 16-Feb-2015


**Order No.:** 14-645 **Date Instructed:** 16-Feb-2015

**No. of Samples:** 5

**Turnaround: (Wkdays)** 7 **Results Due Date:** 24-Feb-2015

**Date Approved:** 24-Feb-2015

**Approved By:**



**Details:** Keith Jones, Technical Manager

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**Results Summary - 2 Stage WAC**  
**Project: 14-645 Greater Dublin Drainage GI: Phase 2**

Chemtest Job No: 15-03479 Chemtest Sample ID: 103338 Sample Ref: Sample ID: BH138 Top Depth(m): 0.00 Bottom Depth(m): Sampling Date:							Landfill Waste Acceptance Criteria Limits			
							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill	
Determinand	SOP	Accred.	Units							
Total Organic Carbon	2625	U	%				3.4	3	5	6
Loss on Ignition	2610	U	%				6.9	--	--	10
Total BTEX	2760	U	mg/kg				A < 0.01	6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg				< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg				A < 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg				6	100	--	--
pH	2010	U					8	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg				0.16	--	To evaluate	To evaluate
Eluate Analysis			2:1 mg/l	8:1 mg/l	2:1 mg/kg	Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg			
Arsenic	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	2	25	
Barium	1450	U	0.015	0.004	< 0.50	< 0.50	20	100	300	
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5	
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70	
Copper	1450	U	0.002	< 0.001	< 0.050	< 0.050	2	50	100	
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2	
Molybdenum	1450	U	0.004	0.001	< 0.050	< 0.050	0.5	10	30	
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40	
Lead	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.5	10	50	
Antimony	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.06	0.7	5	
Selenium	1450	U	0.003	0.001	< 0.010	0.016	0.1	0.5	7	
Zinc	1450	U	< 0.001	< 0.001	< 0.50	< 0.50	4	50	200	
Chloride	1220	U	3.3	2.7	< 10	27	800	15000	25000	
Fluoride	1220	U	0.36	0.11	< 1.0	1.3	10	150	500	
Sulphate	1220	U	18	< 1.0	35	18	1000	20000	50000	
Total Dissolved Solids	1020	N	180	48	350	610	4000	60000	100000	
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-	
Dissolved Organic Carbon	1610	N	7.4	6.5	< 50	65	500	800	1000	

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	23

Leachate Test Information	
Leachant volume 1st extract/l	0.298
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.173

**Results Summary - 2 Stage WAC**  
**Project: 14-645 Greater Dublin Drainage GI: Phase 2**

Chemtest Job No: 15-03479 Chemtest Sample ID: 103339 Sample Ref: Sample ID: TP108 Top Depth(m): 1.00 Bottom Depth(m): Sampling Date:							Landfill Waste Acceptance Criteria Limits			
							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill	
Determinand	SOP	Accred.	Units							
Total Organic Carbon	2625	U	%				2.9	3	5	6
Loss on Ignition	2610	U	%				6.7	--	--	10
Total BTEX	2760	U	mg/kg				A < 0.01	6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg				< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg				A 29	500	--	--
Total (of 17) PAHs	2700	N	mg/kg				< 2.0	100	--	--
pH	2010	U					8	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg				0.19	--	To evaluate	To evaluate
Eluate Analysis			2:1 mg/l	8:1 mg/l	2:1 mg/kg	Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg			
Arsenic	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	2	25	
Barium	1450	U	0.012	0.003	< 0.50	< 0.50	20	100	300	
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5	
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70	
Copper	1450	U	0.002	< 0.001	< 0.050	< 0.050	2	50	100	
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2	
Molybdenum	1450	U	0.003	0.001	< 0.050	< 0.050	0.5	10	30	
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40	
Lead	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.5	10	50	
Antimony	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.06	0.7	5	
Selenium	1450	U	0.003	< 0.001	< 0.010	< 0.010	0.1	0.5	7	
Zinc	1450	U	< 0.001	< 0.001	< 0.50	< 0.50	4	50	200	
Chloride	1220	U	3.3	< 1.0	< 10	< 10	800	15000	25000	
Fluoride	1220	U	0.4	0.14	< 1.0	1.7	10	150	500	
Sulphate	1220	U	14	< 1.0	27	15	1000	20000	50000	
Total Dissolved Solids	1020	N	150	43	290	540	4000	60000	100000	
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-	
Dissolved Organic Carbon	1610	N	56	7.5	110	130	500	800	1000	

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	21

Leachate Test Information	
Leachant volume 1st extract/l	0.303
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.182

**Results Summary - 2 Stage WAC**  
**Project: 14-645 Greater Dublin Drainage GI: Phase 2**

<b>Chemtest Job No: 15-03479</b> <b>Chemtest Sample ID: 103340</b> <b>Sample Ref:</b> <b>Sample ID: TP109</b> <b>Top Depth(m): 0.50</b> <b>Bottom Depth(m):</b> <b>Sampling Date:</b>							<b>Landfill Waste Acceptance Criteria</b> <b>Limits</b>		
							<b>Inert Waste Landfill</b>	<b>Stable Non-reactive Hazardous waste in non-hazardous Landfill</b>	<b>Hazardous Waste Landfill</b>
<b>Determinand</b>	<b>SOP</b>	<b>Accred.</b>	<b>Units</b>						
Total Organic Carbon	2625	U	%				1.1	3	5
Loss on Ignition	2610	U	%				2.9	--	--
Total BTEX	2760	U	mg/kg				A < 0.01	6	--
Total PCBs (7 congeners)	2815	U	mg/kg				< 0.10	1	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg				A < 10	500	--
Total (of 17) PAHs	2700	N	mg/kg				12	100	--
pH	2010	U					7.9	--	>6
Acid Neutralisation Capacity	2015	N	mol/kg				0.58	--	To evaluate
<b>Eluate Analysis</b>			<b>2:1 mg/l</b>	<b>8:1 mg/l</b>	<b>2:1 mg/kg</b>	<b>Cumulative 10:1 mg/kg</b>	<b>Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg</b>		
Arsenic	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	2	25
Barium	1450	U	0.023	0.022	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.004	0.006	< 0.050	0.055	0.5	10	30
Nickel	1450	U	0.003	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.06	0.7	5
Selenium	1450	U	0.006	0.002	0.012	0.02	0.1	0.5	7
Zinc	1450	U	0.017	< 0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	2.2	< 1.0	< 10	< 10	800	15000	25000
Fluoride	1220	U	0.14	0.24	< 1.0	2.3	10	150	500
Sulphate	1220	U	1500	150	3000	3000	1000	20000	50000
Total Dissolved Solids	1020	N	1300	300	2600	4100	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	N	14	5	< 50	60	500	800	1000

<b>Soild Information</b>	
Dry mass of test portion/kg	0.175
Moisture (%)	13

<b>Leachate Test Information</b>	
Leachant volume 1st extract/l	0.325
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.196

**Results Summary - 2 Stage WAC**  
**Project: 14-645 Greater Dublin Drainage GI: Phase 2**

<b>Chemtest Job No: 15-03479</b> <b>Chemtest Sample ID: 103341</b> <b>Sample Ref:</b> <b>Sample ID: TP110</b> <b>Top Depth(m): 1.00</b> <b>Bottom Depth(m):</b> <b>Sampling Date:</b>							<b>Landfill Waste Acceptance Criteria</b> <b>Limits</b>		
							<b>Inert Waste Landfill</b>	<b>Stable Non-reactive Hazardous waste in non-hazardous Landfill</b>	<b>Hazardous Waste Landfill</b>
<b>Determinand</b>	<b>SOP</b>	<b>Accred.</b>	<b>Units</b>						
Total Organic Carbon	2625	U	%				0.63	3	5
Loss on Ignition	2610	U	%				2.4	--	--
Total BTEX	2760	U	mg/kg				A < 0.01	6	--
Total PCBs (7 congeners)	2815	U	mg/kg				< 0.10	1	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg				A < 10	500	--
Total (of 17) PAHs	2700	N	mg/kg				3	100	--
pH	2010	U					8.1	--	>6
Acid Neutralisation Capacity	2015	N	mol/kg				0.34	--	To evaluate
<b>Eluate Analysis</b>			<b>2:1 mg/l</b>	<b>8:1 mg/l</b>	<b>2:1 mg/kg</b>	<b>Cumulative 10:1 mg/kg</b>	<b>Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg</b>		
Arsenic	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	2	25
Barium	1450	U	0.006	0.003	< 0.50	< 0.50	20	100	300
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70
Copper	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	2	50	100
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2
Molybdenum	1450	U	0.001	0.001	< 0.050	< 0.050	0.5	10	30
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40
Lead	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.06	0.7	5
Selenium	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.1	0.5	7
Zinc	1450	U	< 0.001	< 0.001	< 0.50	< 0.50	4	50	200
Chloride	1220	U	9.4	< 1.0	19	11	800	15000	25000
Fluoride	1220	U	0.23	0.11	< 1.0	1.2	10	150	500
Sulphate	1220	U	9.1	< 1.0	18	10	1000	20000	50000
Total Dissolved Solids	1020	N	130	43	260	530	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-
Dissolved Organic Carbon	1610	N	12	12	< 50	120	500	800	1000

<b>Soild Information</b>	
Dry mass of test portion/kg	0.175
Moisture (%)	13

<b>Leachate Test Information</b>	
Leachant volume 1st extract/l	0.324
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.202

**Results Summary - 2 Stage WAC**  
**Project: 14-645 Greater Dublin Drainage GI: Phase 2**

Chemtest Job No: 15-03479 Chemtest Sample ID: 103342 Sample Ref: Sample ID: TP114 Top Depth(m): 1.00 Bottom Depth(m): Sampling Date:							Landfill Waste Acceptance Criteria Limits			
							Inert Waste Landfill	Stable Non-reactive Hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill	
Determinand	SOP	Accred.	Units							
Total Organic Carbon	2625	U	%				0.53	3	5	6
Loss on Ignition	2610	U	%				1.8	--	--	10
Total BTEX	2760	U	mg/kg				A < 0.01	6	--	--
Total PCBs (7 congeners)	2815	U	mg/kg				< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg				A < 10	500	--	--
Total (of 17) PAHs	2700	N	mg/kg				3.1	100	--	--
pH	2010	U					8.3	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg				0.32	--	To evaluate	To evaluate
Eluate Analysis			2:1 mg/l	8:1 mg/l	2:1 mg/kg	Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg			
Arsenic	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	2	25	
Barium	1450	U	0.014	0.003	< 0.50	< 0.50	20	100	300	
Cadmium	1450	U	< 0.0001	< 0.0001	< 0.010	< 0.010	0.04	1	5	
Chromium	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.5	10	70	
Copper	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	2	50	100	
Mercury	1450	U	< 0.0005	< 0.0005	< 0.001	< 0.005	0.01	0.2	2	
Molybdenum	1450	U	0.008	0.002	< 0.050	< 0.050	0.5	10	30	
Nickel	1450	U	< 0.001	< 0.001	< 0.050	< 0.050	0.4	10	40	
Lead	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.5	10	50	
Antimony	1450	U	< 0.001	< 0.001	< 0.010	< 0.010	0.06	0.7	5	
Selenium	1450	U	0.005	0.001	0.011	0.017	0.1	0.5	7	
Zinc	1450	U	< 0.001	< 0.001	< 0.50	< 0.50	4	50	200	
Chloride	1220	U	22	< 1.0	43	29	800	15000	25000	
Fluoride	1220	U	0.39	0.091	< 1.0	1.3	10	150	500	
Sulphate	1220	U	17	< 1.0	33	22	1000	20000	50000	
Total Dissolved Solids	1020	N	160	41	310	560	4000	60000	100000	
Phenol Index	1920	U	< 0.030	< 0.030	< 0.30	< 0.50	1	-	-	
Dissolved Organic Carbon	1610	N	2.9	2.9	< 50	< 50	500	800	1000	

Soild Information	
Dry mass of test portion/kg	0.175
Moisture (%)	19

Leachate Test Information	
Leachant volume 1st extract/l	0.31
Leachant volume 2nd extract/l	1.4
Eluant recovered from 1st extract/l	0.229

### Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63. Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request. The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

<b>Chemtest Sample ID:</b>	<b>Sample Ref:</b>	<b>Sample ID:</b>	<b>Sampled Date:</b>	<b>Containers Received:</b>	<b>Deviation Code(s):</b>
103338		BH138	None Supplied	Amber Glass 250ml	A
103338		BH138	None Supplied	Amber Glass 60ml	A
103338		BH138	None Supplied	Plastic Tub 500g	A
103339		TP108	None Supplied	Amber Glass 250ml	A
103339		TP108	None Supplied	Amber Glass 60ml	A
103339		TP108	None Supplied	Plastic Tub 500g	A
103340		TP109	None Supplied	Amber Glass 250ml	A
103340		TP109	None Supplied	Amber Glass 60ml	A
103340		TP109	None Supplied	Plastic Tub 500g	A
103341		TP110	None Supplied	Amber Glass 250ml	A
103341		TP110	None Supplied	Amber Glass 60ml	A
103341		TP110	None Supplied	Plastic Tub 500g	A
103342		TP114	None Supplied	Amber Glass 250ml	A
103342		TP114	None Supplied	Amber Glass 60ml	A
103342		TP114	None Supplied	Plastic Tub 500g	A

## Report Information

### **Key**

---

- U UKAS accredited
- M MCERTS and UKAS accredited
- N Unaccredited
- S This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
- SN This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
- T This analysis has been subcontracted to an unaccredited laboratory
- I/S Insufficient Sample
- U/S Unsuitable sample
- N/E not evaluated
- < "less than"
- > "greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVCOs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at our Coventry laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

### **Sample Deviation Codes**

---

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container

### **Sample Retention and Disposal**

---

All soil samples will be retained for a period of 60 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

[customerservices@chemtest.co.uk](mailto:customerservices@chemtest.co.uk)

**Appendix G**  
**SPT hammer energy measurement report**



**Mr. David Cameron**  
**Causeway Geotech Ltd.**  
**8 Drumahiskey Road,**  
**balnamore, Ballymoney,**  
**Co Antrim, Northern Ireland.**  
**BT 53 7QL**

SPT Hammer Ref: CG G205  
Test Date: 03/01/2013  
Report Date:  
File Name: CG G205. report spt\_checked.spt  
Test Operator: MR



## Instrumented Rod Data

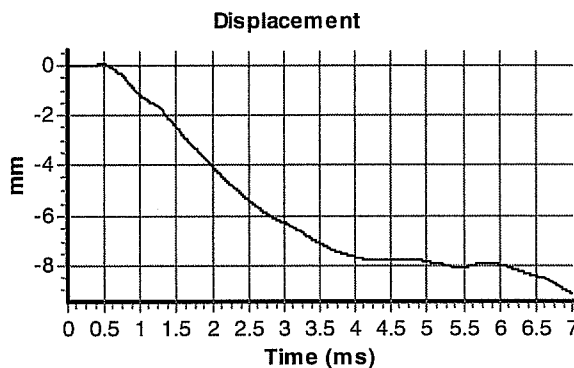
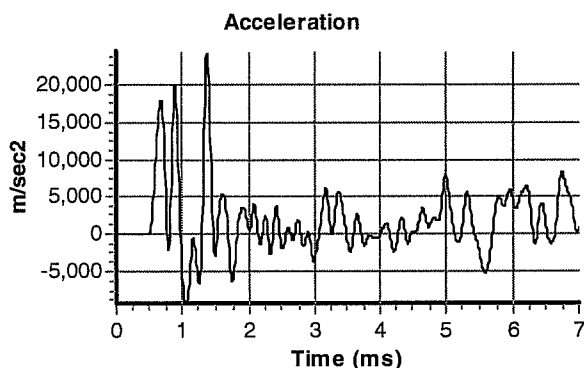
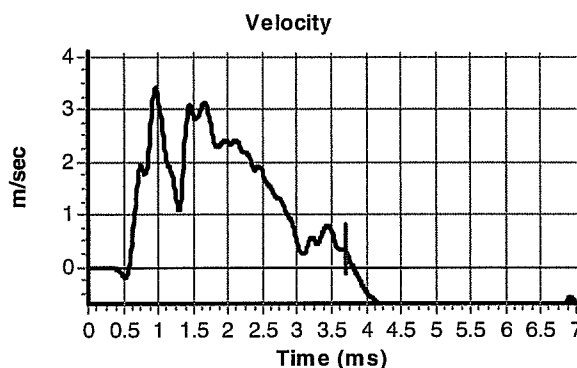
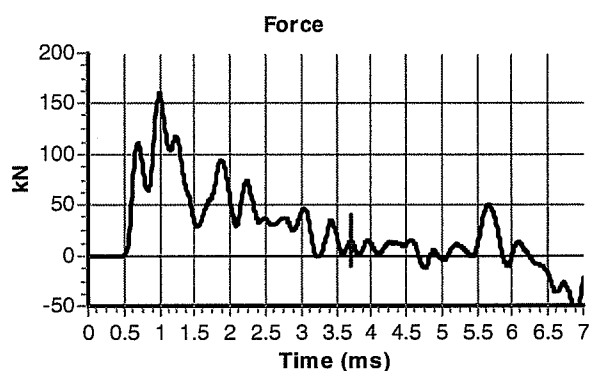
Diameter  $d_r$  (mm): 54  
Wall Thickness  $t_r$  (mm): 6.6  
Assumed Modulus  $E_a$  (GPa): 208  
Accelerometer No.1: 5677  
Accelerometer No.2: 5833

## SPT Hammer Information

Hammer Mass  $m$  (kg): 63.5  
Falling Height  $h$  (mm): 770  
SPT String Length  $L$  (m): 14.0

## Comments / Location

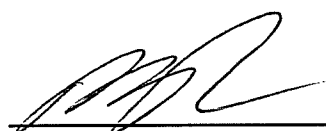
T G205



## Calculations

Area of Rod A (mm<sup>2</sup>): 983  
Theoretical Energy  $E_{theor}$  (J): 473  
Measured Energy  $E_{meas}$  (J): 323

**Energy Ratio  $E_r$  (%):** **68**



Signed: Michael Robinson  
Title: Test Engineer

The recommended calibration interval is 12 months

**Mr. David Cameron**  
**Causeway Geotech Ltd.**  
**8 Drumahiskey Road,**  
**Balnamore, Ballymoney,**  
**Co Antrim, Northern Ireland.**  
**BT 53 7QL**

SPT Hammer Ref: CG CC4  
Test Date: 03/01/2013  
Report Date: 07/01/2013  
File Name: CG CC4. report spt\_checked.spt  
Test Operator: MR



## Instrumented Rod Data

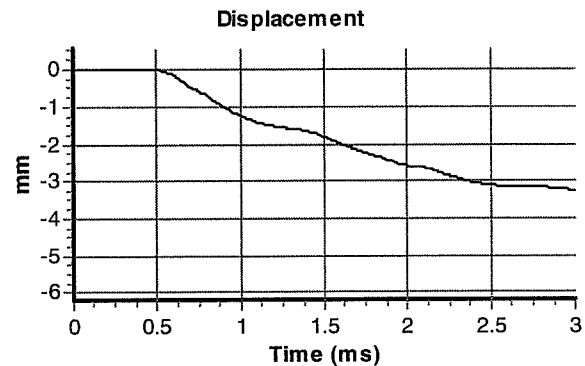
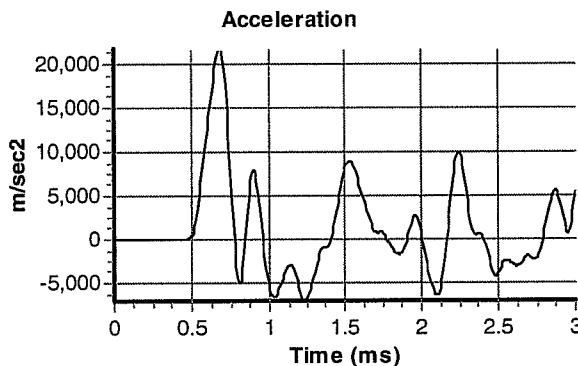
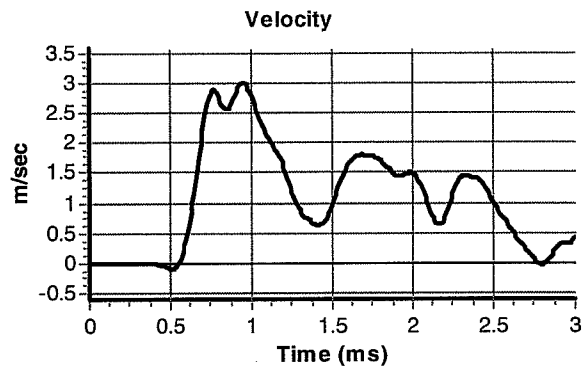
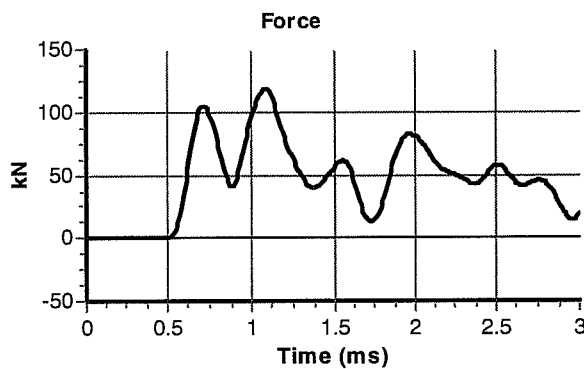
Diameter  $d_r$  (mm): 54  
Wall Thickness  $t_r$  (mm): 6.6  
Assumed Modulus  $E_a$  (GPa): 208  
Accelerometer No.1: 5677  
Accelerometer No.2: 5833

## SPT Hammer Information

Hammer Mass  $m$  (kg): 63.5  
Falling Height  $h$  (mm): 760  
SPT String Length  $L$  (m): 13.0

## Comments / Location

TRIP CC4



## Calculations

Area of Rod A (mm<sup>2</sup>): 983  
Theoretical Energy  $E_{theor}$  (J): 473  
Measured Energy  $E_{meas}$  (J): 272

**Energy Ratio  $E_r$  (%):** **58**



Signed: Michael Robinson  
Title: Test Engineer

The recommended calibration interval is 12 months

**Appendix H**  
**Geophysics report (Apex Geoservices)**

**AGL15015\_01**

**REPORT ON THE  
GEOPHYSICAL SURVEY  
FOR  
GREATER DUBLIN REGIONAL DRAINAGE  
FOR  
CAUSEWAY GEOTECH LTD.**



**APEX Geoservices Limited**  
Unit 6 Knockmullen Business Pk.,  
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E: [info@apexgeoservices.ie](mailto:info@apexgeoservices.ie)  
W: [www.apexgeoservices.com](http://www.apexgeoservices.com)

**26TH FEBRUARY 2015**

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## **PRIVATE AND CONFIDENTIAL**

*THE FINDINGS OF THIS REPORT ARE THE RESULT OF A GEOPHYSICAL SURVEY USING NON-INVASIVE SURVEY TECHNIQUES CARRIED OUT AT THE GROUND SURFACE. INTERPRETATIONS CONTAINED IN THIS REPORT ARE DERIVED FROM A KNOWLEDGE OF THE GROUND CONDITIONS, THE GEOPHYSICAL RESPONSES OF GROUND MATERIALS AND THE EXPERIENCE OF THE AUTHOR. APEX GEOSERVICES LTD. HAS PREPARED THIS REPORT IN LINE WITH BEST CURRENT PRACTICE AND WITH ALL REASONABLE SKILL, CARE AND DILIGENCE IN CONSIDERATION OF THE LIMITS IMPOSED BY THE SURVEY TECHNIQUES USED AND THE RESOURCES DEVOTED TO IT BY AGREEMENT WITH THE CLIENT. THE INTERPRETATIVE BASIS OF THE CONCLUSIONS CONTAINED IN THIS REPORT SHOULD BE TAKEN INTO ACCOUNT IN ANY FUTURE USE OF THIS REPORT.*

<b>PROJECT NUMBER</b>	AGL15015		
<b>AUTHOR</b>	<b>CHECKED</b>	<b>REPORT STATUS</b>	<b>DATE</b>
EURGEOL SHANE O'ROURKE P.GEO., M.Sc (GEOPHYSICS)	TONY LOMBARD M.Sc (GEOPHYSICS)	V.01	26 <sup>TH</sup> FEBRUARY 2015

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## 1. EXECUTIVE SUMMARY

APEX Geoservices Limited was requested by Causeway Geotech Ltd. to carry out a geophysical investigation as part of the site investigation at three locations along the proposed pipeline route for the Greater Dublin Regional Drainage Scheme.

The objectives of the survey were to produce depth to bedrock sections for the sites, to provide information on the type and quality of the bedrock, to provide information on the thickness and stiffness of the superficial deposits and to provide locations for targeted intrusive investigation.

The investigation consisted of 2D Electrical Resistivity Tomography (ERT) and Seismic Refraction Profiling at three locations; GEO-1, GEO-2 and GEO-3.

GEO-1 is in the area of Dubber Cross and c.3km to the west of GEO-2 and GEO-3 which are both in Ballymun. Each area is just to the north of the M50 motorway.

The results for GEO-1 generally indicate made ground followed by firm-very stiff sandy gravelly clay to 1.6-8.2m bgl followed by thin discontinuous highly-moderately weathered bedrock followed by slightly weathered-fresh bedrock.

The results for GEO-2 generally indicate made ground followed by firm-very stiff sandy gravelly clay to 4.9-10.1m bgl followed by thin discontinuous highly-moderately weathered bedrock followed by slightly weathered-fresh bedrock.

The results for GEO-3 generally indicate made ground followed by firm-very stiff sandy gravelly clay to 7.2-8.2m bgl followed by slightly weathered-fresh bedrock.

The invert level for all three areas is within slightly weathered-fresh muddy limestone and shale.

## 2. INTRODUCTION

APEX Geoservices Limited was requested by Causeway Geotech Ltd. to carry out a geophysical investigation as part of the site investigation at three locations along the proposed invert for the Greater Dublin Regional Drainage Scheme.

### 2.1 Survey Objectives

The objectives of the survey were to:

1. Produce depth to bedrock sections for the sites.
2. Provide information on the type and quality of the bedrock.
3. Provide information on the thickness and stiffness of the superficial deposits.
4. Provide locations for targeted intrusive investigation.

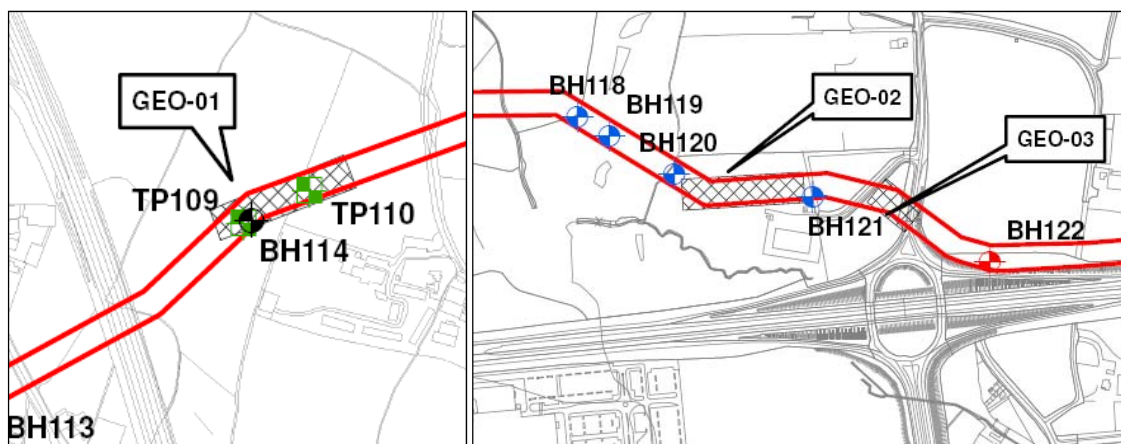
### 2.2 Site Background

ERT and Seismic Refraction Profiling has been carried out at three locations along the Greater Dublin Regional Drainage Scheme, namely GEO-1, GEO-2 and GEO-3. The three areas are located immediately north of the M50 motorway in north county Dublin.

GEO-1 is 200m east of the N2 roadway and comprises 200m of continuous ERT and Seismic Refraction Profiling in a generally flat area of grass/made ground.

GEO-2 is 2.6km east of GEO-1 and 200m west of the R108 roadway and comprises 200m of continuous ERT and Seismic Refraction Profiling in a generally flat area of grass/made ground

GEO-3 is 140m east of GEO-2 and comprises two cross-profiles within a confined area of made ground immediately west of the R108.





### 2.3 Geology

The GSI 1:100k Bedrock Geology map for GEO-1 (Fig.2.1) indicates that the site is located at the boundary of calcareous shale & limestone conglomerate of the Tober Colleen Formation and massive unbedded lime-mudstone of the Waulsortian Limestones.



Fig.2.1. Geological map for the GEO-1 site.

Fig.2.2 indicates that the GEO-2 and GEO-3 sites are located within calcareous shale & limestone conglomerate of the Tober Colleen Formation.

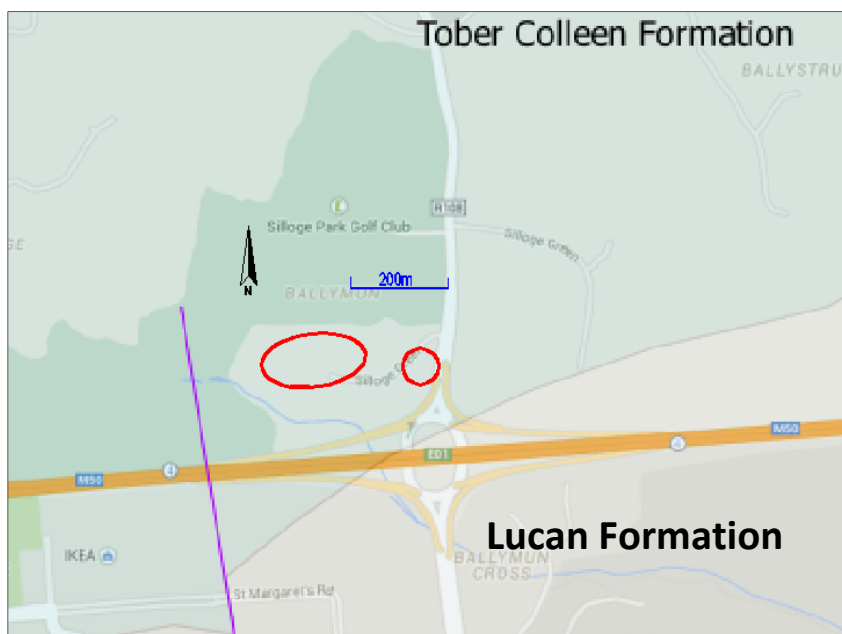


Fig.2.2. Geological map for the GEO-2 and GEO-3 sites.

## 2.4 Soils

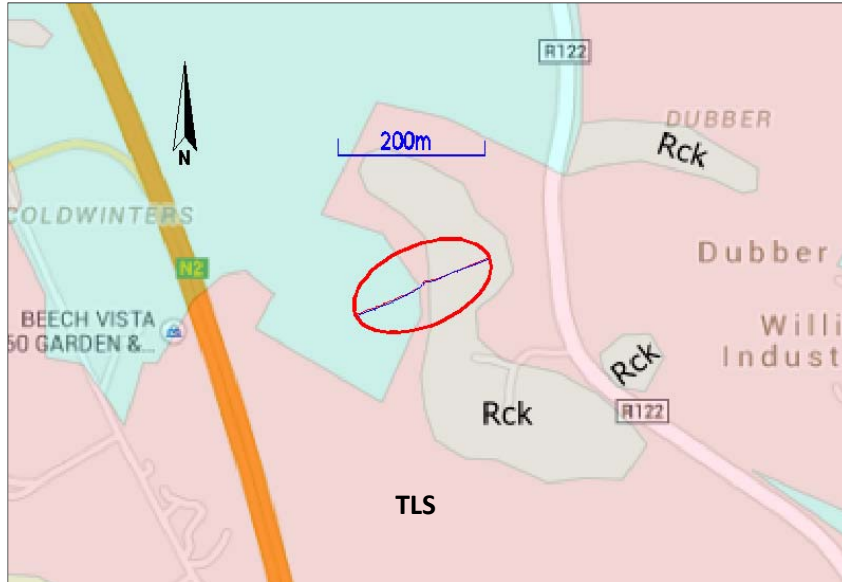


Fig.2.3. Soils map for the GEO-1 site.



Fig.2.4. Soils map for the GEO-2 and GEO-3 sites.

The Teagasc soils map for GEO-1 (Fig.2.3) indicates made ground to the west, followed by till derived from limestone, with outcrop for the eastern 100m of the section. The map shows made ground (Fig.2.4) for GEO-2 and GEO-3.

## 2.5 Vulnerability

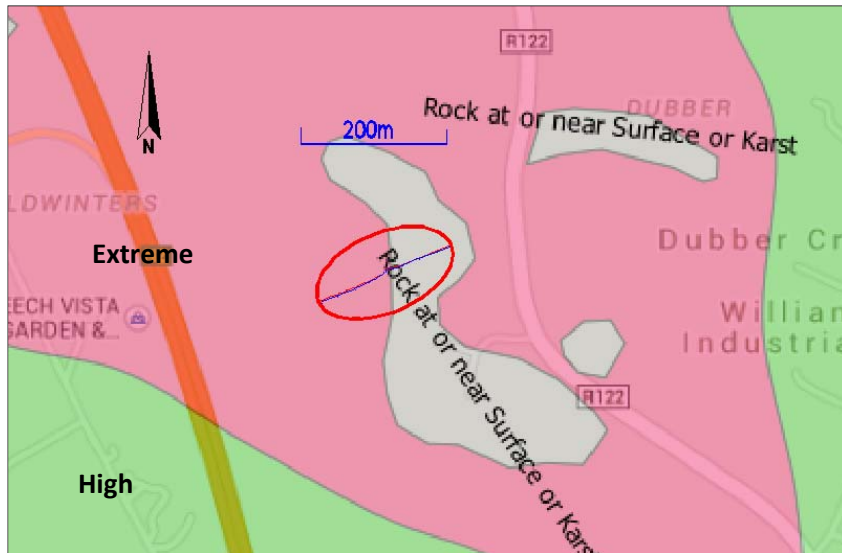


Fig.2.5. Vulnerability map for the GEO-1 site.

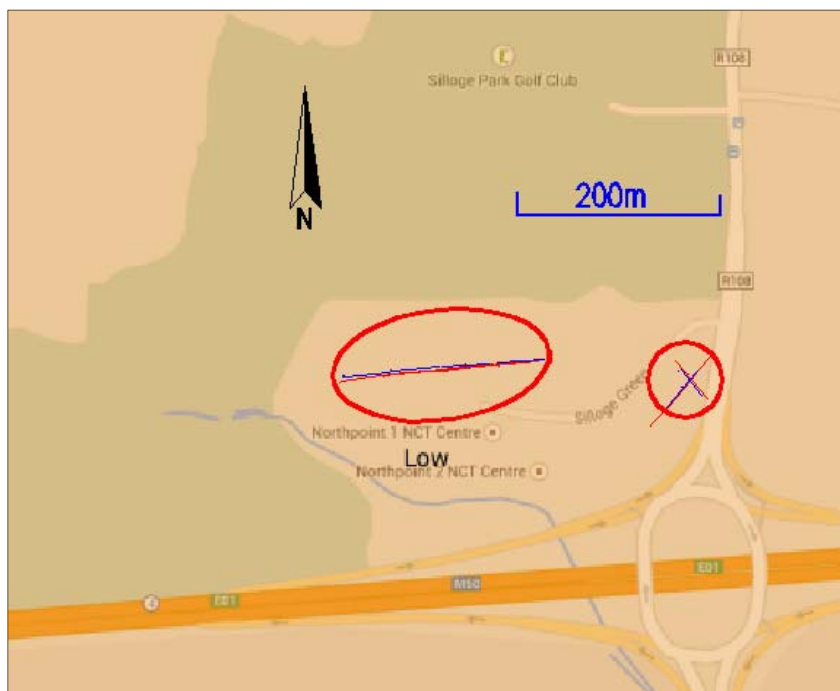


Fig.2.6. Vulnerability map for the GEO-2 and GEO-3 sites.

The vulnerability map for GEO-1 (Fig.2.5) indicates extreme vulnerability to the west and rock at or near surface or karst to the east. The map shows low vulnerability (Fig.2.6) for GEO-2 and GEO-3.

## 2.6 Historical Data

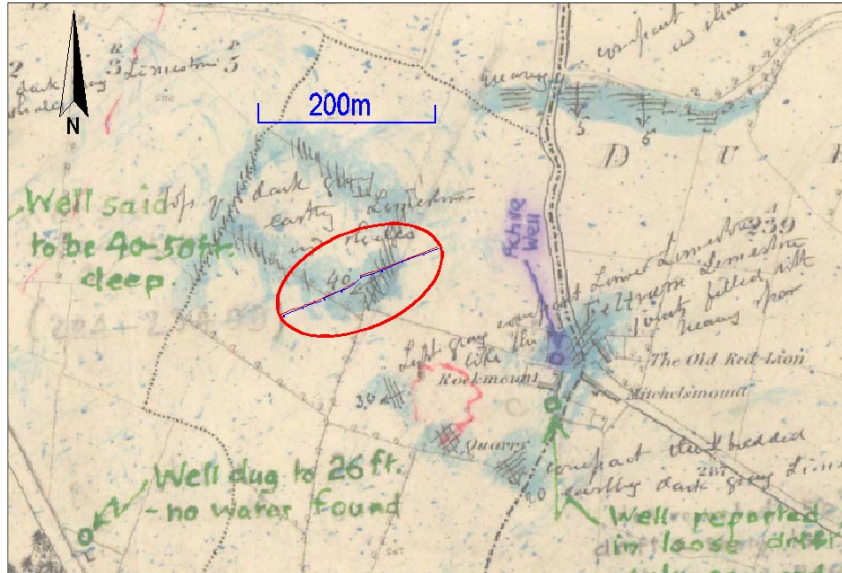


Fig.2.7. 6" Sheet for the GEO-1 site.

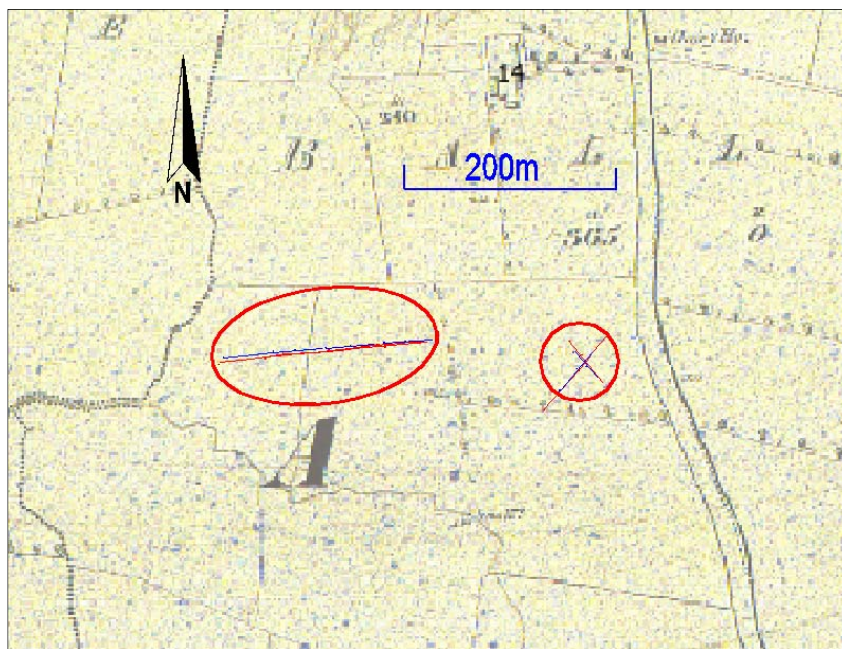


Fig.2.8. 6" Sheet for the GEO-2 and GEO-3 sites.

The 6" Sheet for GEO-1 (Fig.2.7) shows outcrop at the location of the survey comprising dark grey earthy limestones dipping by 40° to the west.

## **2.7 Site Investigation**

BH114 has been drilled at GEO-1 and records made ground followed by stiff clay to 8.5m followed by weathered bedrock to 11.5, and then bedrock.

TP109 at GEO-1 records made ground to 2.2m followed by soft clay to 3.4m. TP110 at GEO-1 records firm to stiff clay to 1.9m followed by weathered bedrock.

BH120-BH121 were both drilled 47-58m to the north of GEO-2 and record firm-hard clay to 11.5-11.9m bgl.

## **2.8 Survey Rationale**

Electrical Resistivity Tomography (ERT) soundings will image the resistivity of the materials in the subsurface along a profile to produce a pseudo-section showing the variation in resistivity to 25m bgl, depending on the length of the profile. Each pseudo-section will be interpreted to determine the material type along the profile at increasing depth, based on the typical resistivities returned for Irish ground materials.

Seismic Refraction Profiling measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities. Readings are taken using geophones connected via multi-core cable to a seismograph. This method should allow us to profile the depth to the top of the bedrock, along profiles across the sites.

### 3. RESULTS & INTERPRETATION

#### 3.1 2D Electrical Resistivity Tomography (ERT)

ERT Profiles R1-R7 have been acquired across the sites (Drawings AGL15015\_02, AGL15015\_03 and AGL15015\_04). The profiles have been interpreted on the following basis:

Resistivity (Ohm.m)	Interpretation
30-50	SILT / CLAY
50-245	Sandy Gravelly Clay
110-145	Weathered Muddy LIMESTONE & SHALE
145-1181	Muddy LIMESTONE & SHALE

#### 3.2 Seismic Refraction Profiling

Ten seismic refraction spreads were recorded throughout the sites, with four at spreads at each of GEO-1 and GEO-2 and two cross-profiles at GEO-3.

The seismic data has outlined four velocity layers and has been generally interpreted on the following basis:

Layer	Seismic Velocity (m/s)	Average Seismic Velocity (m/s)	Thickness (m)	Interpretation	Stiffness/Rock Quality	Excavatability
1	118-753	376	0.3-1.9	Overburden/ Made Ground	Soft-Firm	Diggable
2	533-1296	879	0.1-5.9	Overburden/ Made Ground	Firm-Stiff	Diggable
3	1046-2398	1739	0.1-8.7	Overburden	Stiff-very Stiff	Diggable
				Highly-Moderately Weathered Bedrock	Poor-Fair	Rippable- Break/Blast
4	2455-5030	3283		Slightly Weathered-Fresh Bedrock	Good	Break/Blast

#### 3.3 Discussion

Material with a resistivity of 30-50 and 50-245 ohm.m has been interpreted as silt/clay and sandy gravelly clay respectively. Bedrock with a resistivity of 110-245 and 145-1181 ohm.m has been interpreted as weathered muddy limestone & shale and muddy limestone & shale respectively.

Layer 1. Material with a velocity of 118-753 m/s has been interpreted as soft-firm overburden and made ground which will be diggable.

Layer 2. Material with a velocity of 533-879 m/s has been interpreted as firm-stiff overburden and made ground which will be diggable.

Layer 3. Material with a velocity of 1046-2398 m/s has mainly been interpreted as stiff-very stiff overburden. Some parts of Layer 3 for GEO-1 and GEO-2 have been interpreted as highly-moderately weathered bedrock, which will be rippable to requiring breaking/blasting.

Layer 4. Material with a velocity of 2455-5030 m/s has mainly been interpreted as slightly-weathered to fresh bedrock which will require breaking/blasting upon excavation.

### **3.3.1 GEO-1**

#### Drawing AGL15015\_02

The western half of GEO-1 from 0-90m (local distance along section) has been interpreted as made ground followed by firm-very stiff mainly sandy gravelly clay to 4.0-8.2m bgl. This is followed by thin discontinuous highly-moderately weathered bedrock with a maximum thickness of 3.0m and then slightly weathered-fresh bedrock.

The eastern half of GEO-1 from 90-180m has been interpreted as by soft-very stiff mainly sandy gravelly clay to 1.6-4.0m bgl. This is followed by thin highly-moderately weathered bedrock with a maximum thickness of 3.0m and then slightly weathered-fresh bedrock.

The seismic velocity of Layer 3 will provide an indication as to the excavability of the weathered bedrock. All of the Layer 3 velocities for GEO-1 are generally 1200-1500 m/s which is indicative of rippable-marginally rippable bedrock.

The invert level for GEO-1 is 9.5-13.6m below the current ground level (based on survey elevations which should be checked against the project datum), which is within interpreted slightly weathered-fresh bedrock.

### **3.3.2 GEO-2**

#### Drawing AGL15015\_03

GEO-2 has been interpreted as made ground followed by firm-very stiff sandy gravelly clay to 4.9-10.1m bgl. A zone of thin highly-moderately weathered bedrock has been interpreted from 93-130m with a maximum thickness of 1.8m. The Layer 3 velocities for this zone range from 2204-2385 m/s which is indicative of bedrock requiring breaking/blasting.

This is then followed by slightly weathered-fresh bedrock.

The invert level for GEO-2 is 8.9-10.3m below the current ground level (based on survey elevations which should be checked against the project datum) which is within interpreted slightly weathered-fresh bedrock.

### **3.3.3 GEO-3**

#### Drawing AGL15015\_04

GEO-3 has been interpreted as made ground followed by firm-very stiff mainly sandy gravelly clay to 6.0-9.5m bgl (7.2-8.2m bgl at the locations of the pipeline on R6 and R7 respectively). This is then followed by slightly weathered-fresh bedrock.

The invert level for GEO-3 is 10.0m below the current ground level (based on survey elevations which should be checked against the project datum) which is within interpreted as slightly weathered-fresh bedrock.

Profile R7 is characterised by resistivities which are generally very low for the interpreted material types. These low resistivities are also present to a lesser extent on Profile R6 where it crosses Profile R7. These resistivities are anomalous and may be due to a contaminant material and further investigation is recommended below to determine their cause as low soil resistivities can be indicative of potentially corrosive material.



#### **4. RECOMMENDATIONS**

A trial pit and a borehole are recommended at GEO-3 at ITM 715265E, 741468N to investigate the cause of the low resistivities returned at this location.

The geophysical results should be reviewed upon the completion of any further site investigation.

## 5. REFERENCES

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## **6. APPENDIX A: DETAILED METHODOLOGY**

### **6.1 Electrical Resistivity Tomography (ERT)**

#### **6.1.1 Principles**

This surveying technique makes use of the Wenner resistivity array. The 2D-resistivity profiling method records a large number of resistivity readings in order to map lateral and vertical changes in material types. The 2D-resistivity profiling method involves the use of 1-32 electrodes connected to a resistivity meter, using computer software to control the process of data collection and storage.

#### **6.1.2 Data Collection**

Profiles R1-R7 were recorded using a ABEM resistivity meter, imaging software, one 32 takeout multicore cables and up to 32 stainless steel electrodes. Saline solution was used at the electrode\ground interface in order to gain a good electrical contact required for the technique to work effectively. The recorded data were processed and viewed immediately after the survey. The data was acquired on 3-4<sup>th</sup> January 2015.

#### **6.1.3 Data Processing**

The field readings were stored in computer files and inverted using the RES2DINV package (Campus Geophysical Instruments, 1997) with up to 5 iterations of the measured data carried out for each profile to obtain a 2D-Depth model of the resistivities.

The inverted 2D-Resistivity models and corresponding interpreted geology are displayed on the accompanying drawings. Distance is indicated along the horizontal axis of the profiles. Profiles have been contoured using the same contour intervals and colour codes.

#### **6.1.4 Relocation**

All data were referenced using a Pro-XR Differential GPS system with c.20mm accuracy.

### **6.2 Seismic Refraction Profiling**

#### **6.2.1 Principles**

The seismic refraction profiling method measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities. Readings are taken using geophones connected via multi-core cable to a seismograph.

#### **6.2.2 Data Collection**

Ten seismic spreads were recorded on the 3-4<sup>th</sup> February 2015 using a Geode high-resolution 24 channel digital seismograph with geophone spacings of 2m (with the

exception of Profile S9 which had a 1.5m spacing). The source of the seismic waves was a sledgehammer.

### **6.2.3 Data Processing**

The recorded data was interpreted using the ray-tracing and intercept time methods, to acquire depths to layer boundaries and the P-wave velocities of these layers, using the FIRSTPIX and GREMIX programs.

GREMIX interprets seismic refraction data as a laterally varying layered earth structure. It incorporates the slope-intercept method, parts of the Plus-Minus Method of Hagedoorn (1959), Time-Delay Method, and features the Generalized Reciprocal Method (GRM) of Palmer (1980). Up to four layers can be mapped, one deduced from direct arrivals and three deduced from refractions. Phantoming of all possible travel time pairs can be carried out by adjusting reciprocal times of off shots.

### **6.2.4 Relocation**

All data were referenced using a Pro-XS Differential GPS system with c.20mm accuracy.

## 7. APPENDIX B: SEISMIC REFRACTION PLATES